

## Claims

### We claim

- 5           1.     An agricultural tractor comprising:  
                  an engine;  
                  a transmission driven by the engine  
                  a drive axle driven by the transmission, the drive axle including a  
                  central housing having left and right drive output members, left and right axle  
10            housings movably coupled to the central housing for vertical movement of the left  
                  and right axle housings relative to the central housing, left and right axle shafts  
                  rotatably carried by the left and right axle housings and left and right universal joints  
                  drivingly coupling the left and right drive output members to the left and right axle  
                  shafts respectively; and  
15            left and right wheel and tire assemblies coupled to the left and right  
                  axle shafts respectively.
2.     The agricultural tractor as defined by claim 1 further comprising left and  
                  right inboard final drives in the central axle housing whereby the left and right drive  
20            output members rotate at the same speed as the left and right axle shafts,  
                  respectively.
3.     The agricultural tractor as defined by claim 2 wherein the output  
                  members are planet carriers of the inboard final drives.  
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4.     The agricultural tractor as defined by claim 1 wherein the left and right  
                  wheel and tire assemblies are positioned at a 60 inch tread spacing.
5.     The agricultural tractor as defined by claim 1 further comprising means  
30            for infinitely adjusting the position of the wheel and tire assemblies along the left and  
                  right axle shafts.

6. The agricultural tractor as defined by claim 5 wherein the left and right wheel and tire assemblies are positioned at a 60 inch tread spacing.

5 7. The agricultural tractor as defined by claim 6 wherein the central housing includes left and right inboard final drives.

8. The agricultural tractor as defined by claim 6 wherein the engine has a power rating of at least 75 kW (100 hp).

10 9. The agricultural tractor as defined by claim 6 wherein the engine has a power rating of at least 124 kW (165 hp).

15 10. The agricultural tractor as defined by claim 1 wherein the central housing is part of a agricultural tractor frame.

20 11. The agricultural tractor as defined by claim 10 wherein the left and right axle housings are each coupled to the central housing by left and right upper and lower control arms pivotally coupled to the central housing and the axle housings for movement of the axle housings relative to the central housing and at least one spring member extending between the frame and the axle housing to resiliently transmit loads from the frame to the axle housings.

25 12. The agricultural tractor as defined by claim 11 wherein the spring member is a hydraulic cylinder and extendable rod coupled to the central housing and to the axle housing, the hydraulic cylinder being connected in a hydraulic circuit with at least one pressure accumulator.

30 13. The agricultural tractor as defined by claim 11 further comprising a rotary potentiometer to measure the rotary position of one of the control arms.

14. The agricultural tractor as defined by claim 11 wherein the control arms are coupled to the axle housing by upper and lower ball joints wherein the upper and lower ball joints define an upright axis about which the axle housing can pivot to turn the wheel and tire assemblies and further comprising a variable length member  
5 between the central housing and the axle housing to control rotation of the axle housing about the upright axis.

15. The agricultural tractor as defined by claim 14 wherein the variable length member is a hydraulic cylinder.

16. The agricultural tractor as defined by claim 1 wherein the left and right axle housings are mechanically separated from one another whereby one axle housing can move without causing the other axle housing to move through a mechanical coupling.

17. The agricultural tractor as defined by claim 1 wherein the universal joint comprises:

a drive yoke at an outboard end of the drive output member, the drive yoke defining an outboard face;

a first journal member coupled to the drive yoke for pivotal motion about a first joint pivot axis transverse to a longitudinal axis of the drive output member, the first joint pivot axis being inboard of the drive yoke outboard face;

a coupling yoke joined to the first journal member for pivotal motion about a second joint pivot axis transverse to the longitudinal axis of the drive output member and transverse to the first joint pivot axis;

a driven yoke at an inboard end of the axle shaft, the driven yoke defining an inboard face;

a second journal member coupled to the second yoke for pivotal motion about a third joint pivot axis transverse to a longitudinal axis of the axle shaft, the third joint pivot axis being outboard of the driven yoke inboard face; and

the second journal member being joined to the coupling yoke for pivotal

motion about a fourth joint pivot axis transverse to the longitudinal axis of the axle shaft and transverse to the third joint pivot axis.

18. The agricultural tractor as defined by claim 17 wherein the outboard  
5 face of the drive yoke and the inboard face of the driven yoke are axially adjacent to one another.

19. The agricultural tractor as defined by claim 17 wherein the outboard  
face of the drive yoke and the inboard face of the driven yoke are axially spaced less  
10 than one inch from one another.

20. The agricultural tractor as defined by claim 17 wherein the first journal  
member is an annular member surrounding a hub of the central housing.

21. The agricultural tractor as defined by claim 17 wherein the second  
15 journal member is an annular member surrounding a hub of the axle housing.

22. The agricultural tractor as defined by claim 17 further comprising inner  
bearings carried by a hub in the central housing and supporting the drive output  
20 member therein, the inner bearings extending axially outward beyond the first and second joint pivot axes; and

outer bearings carried by a hub in the axle housing and supporting the  
axle shaft therein, the outer bearings extending axially inward beyond the third and  
fourth joint pivot axes.

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23. The agricultural tractor as defined by claim 1 wherein the universal joint comprises:

an drive yoke at an outboard end of the drive output member;

an driven yoke at in inboard end of the axle shaft;

5 inboard and outboard journal members pivotally coupled to the drive and driven yokes respectively;

a coupling yoke pivotally coupled to both the inboard and outboard journal members; and

10 the inboard and outboard journal members and the coupling yoke being positioned radially outward of the drive yoke and driven yoke.

24. The agricultural tractor as defined by claim 23 wherein the central housing has an axially extending bearing hub supporting the drive output member, and the inboard journal member radially surrounds the bearing hub.

15 25. The agricultural tractor as defined by claim 23 wherein the axle housing has an axially extending bearing hub supporting the axle shaft, and the outboard journal member radially surrounds the bearing hub.

20 26. An agricultural tractor comprising:

a frame;

an engine;

a transmission driven by the engine;

25 a drive axle assembly driven by the transmission, the axle assembly including differential case having left and right planetary final drives, the final drives having an output member, left and right inner suspension housings fixed to the differential case, left and right upper and lower control arms pivotally coupled to the inner suspension housings and extending outward to distal ends, left and right axle housings pivotally coupled to the distal ends of the control arms for up and down  
30 movement of the axle housings relative to the inner suspension housings, left and right axle shafts rotatably carried by the left and right axle housings, left and right

universal joints drivingly coupling the output members of the left and right final drives to the left and right axle shafts respectively, and left and right spring members extending between the left and right inner suspension housings and the left and right axle housings to resiliently transmit loads from the frame to the axle housings; and

5 left and right wheel and tire assemblies coupled to the left and right axle shafts respectively.

27. The agricultural tractor as defined by claim 26 wherein the left and right wheel and tire assemblies are located on the axle shafts to provide a 60 inch tread  
10 width.

28. The agricultural tractor as defined by claim 26 wherein the left and right wheel and tire assemblies are adjustable in position along the left and right axle shafts.  
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29. The agricultural tractor as defined by claim 26 wherein the differential case and the left and right inner housings are rigidly fixed to and part of the frame.

30. The agricultural tractor as defined by claim 26 wherein:  
20 the control arms are coupled to the inner suspension housings by pins that define upper and lower pivot axes; and  
the axle housings are coupled to the distal ends of the control arms by an upper ball joint and a lower ball joint.

31. The agricultural tractor as defined by claim 30 further comprising left and right connecting links extending between the left and right inner suspension housings and left and right axle housings to prevent rotation of the left and right axle housings about left and right upright axes defined by the left and right upper and lower ball joints.  
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32. The agricultural tractor as defined by claim 30 further comprising left and right variable length members extending between the left and right inner housings and left and right axle housings to control rotation of the left and right axle housings about left and right upright axes defined by the left and right upper and lower ball joints to control turning of the left and right wheel and tire assemblies for steering of the tractor.

33. The agricultural tractor as defined by claim 32 wherein the variable length member is a hydraulic cylinder.

34. The agricultural tractor as defined by claim 26 wherein the left and right spring members include hydraulic cylinders coupled in a hydraulic circuit to one or more pressure accumulators.

35. A four-wheel drive agricultural tractor comprising:  
a front portion having a front drive axle;  
a rear portion having a rear drive axle, the front and rear portions being joined to one another by an articulating joint and both the front and rear drive axle assembly having left and right wheel and tire assemblies;  
at least one of the front and rear drive axles having a central housing having left and right drive output members, left and right axle housings coupled to the central housing for vertical movement of the left and right axle housings relative to the central housing, left and right axle shafts rotatably carried by the left and right axle housings and left and right universal joints drivingly coupling the left and right drive output members to the left and right axle shaft respectively, the wheel and tire assemblies of the drive axle assembly being mounted to the left and right axle shafts.

36. The agricultural tractor as defined by claim 35 further comprising left and right inboard final drives in the central axle housing whereby the left and right drive output members rotate at the same speed as the left and right axle shafts respectively.

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37. The agricultural tractor as defined by claim 36 wherein the output members are planet carriers of the inboard final drives.

38. The agricultural tractor as defined by claim 35 wherein the left and right axle housings are each coupled to the central housing by upper and lower control arms pivotally coupled to the inner and axle housings for movement of the axle housings relative to the central housing and at least one spring member extending between the frame and the axle housing to resiliently transmit loads from the frame to the axle housings.

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39. The agricultural tractor as defined by claim 35 wherein each universal joint comprises:

an drive yoke at an outboard end of the drive output member;

an driven yoke at in inboard end of the axle shaft;

20 inboard and outboard journal members pivotally coupled to the drive and driven yokes respectively;

a coupling yoke pivotally coupled to both the inboard and outboard journal members;

25 the inboard and outboard journal members and the coupling yoke being positioned radially outward of the drive yoke and driven yoke wherein the drive yoke and driven yoke are axially adjacent one another.



40. A universal joint for transmitting rotary power:  
a drive member rotatably supported in a first housing by a first bearing set for rotation about a first longitudinal axis;  
a driven member rotatably supported in a second housing by a second  
5 bearing set for rotation about a second longitudinal axis;  
a drive yoke fixed to the drive member;  
a first journal member coupled to the drive yoke for pivotal motion about a first joint pivot axis transverse to a longitudinal axis of the drive member;  
a coupling yoke joined to the first journal member for pivotal motion  
10 about a second joint pivot axis transverse to the longitudinal axis of the drive member and to the first joint pivot axis and lying in the same plane as the first joint pivot axis;  
a driven yoke fixed to the driven member;  
a second journal member coupled to the driven yoke for pivotal motion  
15 about a third joint pivot axis transverse to the second longitudinal axis; and  
the second journal member being joined to the coupling yoke for pivotal motion about a fourth joint pivot axis transverse to the second longitudinal axis and to the third joint pivot axis and lying in the same plane as the third joint pivot axis;  
and  
20 at least a portion of the first and second bearing sets being located between the plane of the first and second joint pivot axes and the plane of the third and fourth joint pivot axes.

41. The universal joint as defined by claims 40 wherein the first and  
25 second journal members and the coupling yoke radially surround the drive and driven yokes.

- 42 The universal joint as defined by claims 40 wherein the first and  
second journal members are each two piece members with the two pieces of each  
30 journal member joined together along radially extending planes.

43     The universal joint as defined by claims 40 wherein the coupling yoke is a two piece member joined together along an axially extending plane.

44.     A suspended drive axle for a work vehicle comprising:  
5         a differential case having left and right planetary final drives, the final drives having each having an output member;  
          left and right inner suspension housings fixed to the differential case;  
          left and right upper and lower control arms pivotally carried by the inner suspension housings and extending outward to distal ends;  
10         left and right axle housings pivotally coupled to the distal ends of the control arms for up and down movement of the axle housings relative to the inner suspension housings;  
          left and right axle shafts rotatably carried by the left and right axle housings;  
15         left and right universal joints drivingly coupling the output members of the left and right final drives to the left and right axle shafts respectively; and  
          left and right spring members extending between the left and right inner suspension housings and the left and right axle housings to resiliently transmit loads therebetween.

20     45.     The drive axle as defined by claim 44 wherein:  
          the control arms are coupled to the inner suspension housings by pins that define upper and lower pivot axes; and  
          the axle housings are coupled to the distal ends of the control arms by  
25     an upper and a lower ball joint.

46.     The drive axle as defined by claim 45 further comprising left and right connecting links extending between the left and right inner suspension housings and left and right axle housings to prevent rotation of the left and right axle housings  
30     about left and right upright axes defined by the left and right upper and lower ball joints.

47. The drive axle as defined by claim 45 further comprising left and right variable length members extending between the left and right inner housings and left and right axle housings to control rotation of the left and right axle housings about left and right upright axes defined by the left and right upper and lower ball joints to control turning of the left and right wheel and tire assemblies for steering of the tractor.

48. The drive axle as defined by claim 47 wherein the variable length member is a hydraulic cylinder.

49. The drive axle as defined by claim 44 wherein the left and right spring members include hydraulic cylinders coupled in a hydraulic circuit to one or more pressure accumulators.

50. The drive axle as defined by claim 44 wherein each universal joint comprises:

an drive yoke at an outboard end of the drive output member;

an driven yoke at in inboard end of the axle shaft;

inboard and outboard journal members pivotally coupled to the drive and driven yokes respectively;

a coupling yoke pivotally coupled to both the inboard and outboard journal members;

the inboard and outboard journal members and the coupling yoke being positioned radially outward of the drive yoke and driven yoke wherein the drive yoke and driven yoke are axially adjacent one another.

51. An agricultural tractor comprising:

a frame;

an operator's platform;

rear wheels;

- 5 a rear axle carrying the rear wheels and including a suspension system coupling the rear wheels to the frame for vertical motion of the rear wheels relative to the frame, the suspension system including a hydro-pneumatic spring system including at least one hydraulic cylinder on each side of the tractor, the extension of the cylinder rod determining the position of the rear wheels relative to the frame; and
- 10 a switch at the operator's platform for actuation by an operator to raise and lower the rear end of the tractor by extending or retracting the cylinder rod of the hydraulic cylinders.